

CLAIMS

1. A system for assisting a driver operating a vehicle traveling on a road, the system comprising:

5 a reaction force device that determines different reaction force values respectively based on stable information and transient information regarding the vehicle and an obstacle detected in a path of the vehicle;

10 a driver controlled input device manually operable by the driver; and
 an actuator coupled to the driver controlled input device and responsive to the reaction force device to selectively transmit the reaction force values to the driver via a reaction force input from the driver controlled input device.

15 2. The system as recited in claim 1, wherein the stable information includes speed of the vehicle and a distance from the vehicle to the obstacle, and the transient information includes the distance from the vehicle to the obstacle and a relative speed of the vehicle with respect to the obstacle.

20 3. The system as recited in claim 2, wherein the reaction force device includes a risk calculation device that determines different risks based on the stable information and the transient information.

25 4. The system as recited in claim 3, wherein the reaction force device includes a reaction force calculation device that calculates the different reaction force values as a function of the different risks respectively.

30 5. The system as recited in claim 4, wherein the reaction force device includes a weighting device that weights the reaction force value based on the transient information, and a reaction force selection device that selects the reaction force value with the greatest absolute value from among the reaction force value based on the stable information and the reaction force value based on the weighted transient information, the reaction force selection device

providing a signal to the actuator that is indicative of the selected reaction force value.

6. The system as recited in claim 5, wherein the reaction force device
5 includes a first target discrimination device that determines whether the detected obstacle is a target obstacle by effecting a first target discrimination based on the speed of the vehicle and the distance from the vehicle to the detected obstacle, and a second target discrimination device that determines whether the detected obstacle is a target obstacle by effecting a second target discrimination based on the distance from the vehicle to the detected obstacle
10 and the relative speed of the vehicle with respect to the detected obstacle.

7. The system as recited in claim 6, further comprising:
a first repulsive force calculation device determining a first repulsive force value versus the first risk;
a second repulsive force calculation device determining a second repulsive force versus the second risk;
a repulsive force selection device selecting the greatest one, in absolute value, among a set of repulsive force values including the first and second repulsive force values;
a correction amount calculation device receiving the selected repulsive force value and determining a correction amount; and
a correction device reducing a driving force applied to the vehicle in response to the correction amount.

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8. The system as recited in claim 7, further comprising:
a sensor detecting a driver power demand;
a driving force request generation device receiving the driver power demand and generating a driving force request versus the driver power demand;
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an engine controller controlling an engine of the vehicle in response to the driving force request for generation of the driving force applied to the vehicle; and

5 wherein the correction device modifies, in response to the determined correction amount, a relationship between the generated driving force and the driver power demand in a direction of providing a reduction in the driving force.

9. The system as recited in claim 7, further comprising:

10 a sensor detecting a driver brake demand;

a braking force request generation device receiving the driver brake demand and generating a braking force request versus the driver brake demand; and

15 a brake controller controlling a brake system of the vehicle in response to the braking force request for generation of a braking force applied to the vehicle; and

wherein the correction device modifies a relationship between the generated braking force and the driver brake demand in a direction of providing an increase in the braking force.

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10. The system as recited in claim 5, wherein the weighting device performs the weighting of the reaction force value based on the transient information when the different risks are each greater than a predetermined value.

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11. The system as recited in claim 5, wherein the weighting device performs the weighting of the reaction force value based on the transient information when the reaction force value is based on the transient information is greater than the reaction force value based on the stable information and the different risks are each greater than a predetermined value.

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12. The system as recited in claim 5, wherein the weighting device performs the weighting of the reaction force value based on the transient information if the weighted reaction force based on the transient information is greater than the reaction force value based on the stable information and that
5 the different risks are each greater than a predetermined value,

13. The system as recited in claim 5, further comprising a scene recognition device that detects an obstacle in the path of the vehicle, the scene recognition device determining whether the obstacle is stationary or in motion,
10 and wherein the weighting device performs the weighting of the reaction force value based on the transient information heavier upon determination that the obstacle is in motion than it does upon determination that the obstacle is stationary.

15 14. The system as recited in claim 5, further comprising a scene recognition device that detects an obstacle in the path of the vehicle, the scene recognition device determining whether or not the obstacle is being decelerated, and wherein the weighting device performs the weighting of the reaction force value based on the transient information heavier upon determination that the obstacle is being decelerated than it does upon
20 determination that the obstacle is not being decelerated.

15. The system as recited in claim 6,
wherein the first target discrimination device determines that the
25 detected obstacle is the target obstacle when a time headway (THW), which is obtained by dividing the distance by the vehicle speed, is less than a first threshold value, and

wherein the second target discrimination device determines that the detected obstacle is the target obstacle when a time to collision (TTC), which
30 is obtained by dividing the distance by the relative vehicle speed, is less than a

second threshold value.

16. The system as recited in claim 1, wherein the driver controlled input device includes at least one of an accelerator pedal and a brake pedal.

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17. The system as recited in claim 3, wherein the risk calculation device includes first and second risk calculation devices that respectively calculate first and second risks as the different risks, and the reaction force calculation devices includes first and second reaction force calculation devices that respectively calculate first and second reaction force values as the different reaction force values, the system further comprising:

a first contact possibility discrimination device determining whether or not the vehicle may come into contact with the detected obstacle by effecting contact possibility discrimination based on the distance and the vehicle speed;

15 a third risk calculation device determining a third risk from the detected obstacle upon determination, by the first contact possibility discrimination device, that the vehicle may come into contact with the detected obstacle;

a third reaction force calculation device determining a third reaction force value versus the third risk;

20 a second contact possibility discrimination device determining whether or not the vehicle may come into contact with the detected obstacle by effecting contact possibility discrimination based on the distance and the relative vehicle speed;

25 a fourth risk calculation device determining a fourth risk from the detected obstacle upon determination, by the second contact possibility discrimination device, that the vehicle may come into contact with the detected obstacle; and

a fourth reaction force calculating device determining a fourth reaction force value versus the fourth risk, and

30 wherein the set of reaction force values includes the third and fourth

reaction force values in addition to the first reaction force value and the weighted second reaction force value, whereby the reaction force selection device selects the greatest one among the first reaction force value, the weighted second reaction force value, the third reaction force value, and the
5 fourth reaction force value.

18. A vehicle, comprising:

a scene recognition device detecting an obstacle in the path of the vehicle;

10 a first target discrimination device determining whether or not the detected obstacle is a target obstacle by effecting a first target discrimination based on a vehicle speed of the vehicle and a distance to the detected obstacle from the vehicle;

15 a first risk calculation device determining a first risk from the detected obstacle upon determination, by the first target discrimination device, that the detected obstacle is the target obstacle;

a first reaction force calculation device determining a first reaction force value versus the fist risk;

20 a second target discrimination device determining whether or not the detected obstacle is a target obstacle by effecting a second target discrimination based on the distance to the detected obstacle and a relative vehicle speed of the vehicle with respect to the detected obstacle;

25 a second risk calculation device determining a second risk from the detected obstacle upon determination, by the second target discrimination device, that the detected obstacle is the target obstacle;

a second reaction force calculation device determining a second reaction force value versus the second risk;

a weighting device performing a weighting of the second reaction force value;

30 a reaction force selection device selecting the greatest one, in absolute

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value, among a set of reaction force values including the first reaction force value and the weighted second reaction force value and providing an output signal indicative of the selected reaction force value;

5 a driver controlled input device manually operable by a driver; and
an actuator coupled to the driver controlled input device and operative in response to the output signal to transmit the selected reaction force value to the driver via a reaction force input from the driver controlled input device.

10 19. A method for assisting a driver operating a vehicle traveling on a road, the method comprising:

detecting an obstacle in the path of the vehicle;
determining whether or not the detected obstacle is a target obstacle by effecting a first target discrimination based on a vehicle speed of the vehicle and a distance to the detected obstacle from the vehicle;

15 determining a first risk from the detected obstacle upon determination, by the first target discrimination, that the detected obstacle is the target obstacle;

determining a first reaction force value versus the first risk;
determining whether or not the detected obstacle is a target obstacle by 20 effecting a second target discrimination based on the distance to the detected obstacle and a relative vehicle speed of the vehicle with respect to the detected obstacle;

determining a second risk from the detected obstacle upon determination, by the second target discrimination, that the detected obstacle is 25 the target obstacle;

determining a second reaction force value versus the second risk;
performing a weighting of the second reaction force value;
selecting the greatest one, in absolute value, among a set of reaction force values including the first reaction force value and the weighted second 30 reaction force value and providing an output signal indicative of the selected

reaction force value;

transmitting the selected reaction force value indicated by the output signal to the driver via a reaction force input from a driver controlled input device manually operable by the driver.

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20. A system for assisting a driver operating a vehicle traveling on a road, the system comprising:

means for detecting an obstacle in front of the vehicle;

means for conducting one of different analyses of the detected obstacle
10 to provide one of different partially overlapped periods allowing determination
of a risk derived from the detected obstacle to give a variable;

means for selecting one out of concurrently occurring ones of the variables to interconnect the variables into a final variable existing over at least two adjacent different periods; and

15 means for transmitting the final variable to the driver via a haptic input.